Wilhelm Burger, Mark Burge (eds.)

Pattern Recognition 1997

Proceedings of the 21st Workshop of the
Austrian Association for Pattern Recognition
(ÖAGM/AAPR)
Hallstatt, Upper Austria, May 26-27, 1997

R.Oldenbourg Wien München 1997

Applications

Sending Live Video Over Internet

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Abstract: *The design and application of Internet Video Server (IVS) which enables Live video transmission and remote camera control over WWW is presented. The GlobalView extension of IVS enables the generation of panoramic images of the environment and a more intuitive control of the camera.*

1 Introduction

Live video transmission over Internet and interactivity are becoming more and more popular. This very moment we can find on the World Wide Web hunderts of cameras all across the world that we can use as our remote eyes [1]. Video can give us information that static images can not (telepresence) and with further development of technology and Internet infrastructure the speed of transmission and the amount of video imagery will only increase. Therefore, intelligent control of video capture by means of changing the view direction, spatial structuring of visual information, as well as generation of visual summary are essential for successful application of this technology. To study such user-interface issues of remotely operable cameras and provide a testbed for the application of computer vision techniques (motion detection, tracking, security) we developed the Internet Video Server (IVS) system [2, 3] which we recently expanded with the GlobalView extension.

2 Internet Video Server

IVS enables live video transmission and remote camera control over the Word Wide Web. In designing the system certain objectives were followed: (1) client side platform independence, (2) optimization for slow connections, and (3) remote control of the camera. Platform independence of clients was easily achieved by using the World Wide Web technology - HTTP (HyperText Transfer Protocol) and

*This work was supported by the Ministry of Science and Technology of Republic of Slovenia (Project L2-8721) and by the European Cultural Month Ljubljana 1997 (Project Netropolis – Cyborg's Eye).

HTML. Netscape Navigator version 2.0 or above is recommended, since some extensions of HTML were used.

For greater flexibility the camera can be placed to a location without or with a slow Internet connection. This is made possible by a two-level IVS system architecture. The first level is the distribution level and the second is the camera level (Fig. 1). The camera sends processed images to the level 1 which distributes them to all clients on the Internet. Therefore the distribution level has to have a relatively fast Internet connection as it has to deal with one server to many clients relationship. Requests that come from the clients on Internet are filtered and processed by level 1 and only necessary data and control commands are sent to level 2. Therefore the main task of level 2 is digitizing and compressing the picture and the channel between the two levels is optimized for data transfer.

IVS can also operate in a single-level mode. Using this mode we loose advantages of parallel processing of the two-level mode. The camera level would have to serve also the requests that come from the clients and this would cause a reduction of performance.

2.1 IVS Modules

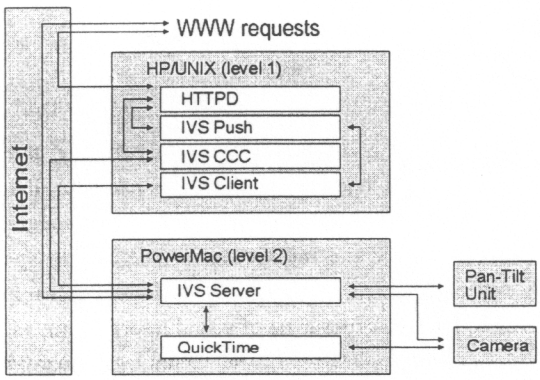

Figure 1: IVS modules

IVS consists of four specialized modules (Fig. 1) and a few general modules which are part of the system software.

IVS-Server

The heart of the IVS is the IVS-Server module which runs on the camera level. Its main tasks are serving the requests that come from clients (internal or external), digitizing and processing the image and controlling the camera and the pan-tilt unit. Images are digitized in resolution 120×160 pixels and then transformed into JPEG format.

IVS-Server can serve two sets of requests:

- The first set consists of requests sent by IVS-Client module which runs on the distribution level. They are referred as IVS requests.
- The second set are HTTP requests that come directly from clients on the Internet. HTTP requests are served when operating in single-level mode.

In both sets are requests for: single image, continuous image stream, control of the camera and pan-tilt unit, and status of the module.

IVS-Client

This module is located on the distribution level and transports images between the two levels. At first, the persistent connection is established with the IVS-Server module with request for continuous image stream. Every image that this module receives is accessible by multiple concurrently running IVS-Push modules. IVS-Client has to be harmonized with IVS-Push modules.

IVS-Push

This module sends the images to clients on the Internet. For each client a separate instance of this module is executed. This enables independence between serving requests.

IVS-CCC – Camera Control Center

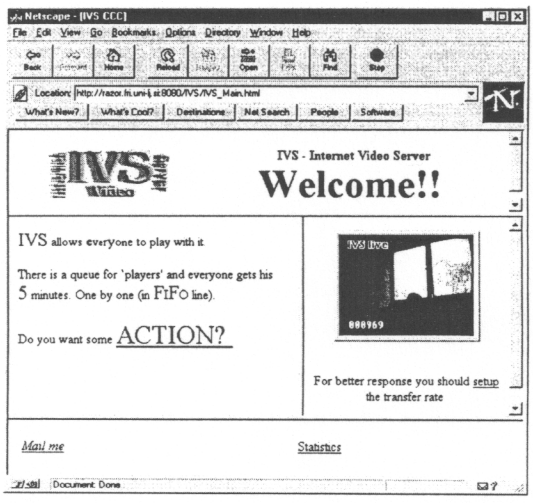

Figure 2: IVS user interface

The Camera Control Center is the front end of the system (Fig. 2). Through this module the user interaction is carried out. Using this module the camera can be moved in all directions (left, right,

up and down) or turned to some predefined position. Only one user can interact with the system at the time and therefore a queue has been implemented to allow fair time sharing. Every user gets 5 minutes to control the camera. Then the control is passed to the next request in the queue.

3 GlobalView extension

Observing a distant location through IVS or a similar system gives a somewhat limited perception akin to looking at the surrounding through a long tube. Due to precisely controlled position of the camera individual images acquired by IVS can be assembled in a panoramic view of the entire surroundings. The GlobalView interface thus enables IVS users to have a better spatial perception of the observed location and a more intuitive control of the camera platform.

Panoramic views have been traditionally generated by special photographic cameras and photographic techniques by means of rotation. Today special parabolic mirrors are usually applied to capture a large portion of the surroundings [4, 5]. To get a proper perspective view these images must be mathematically processed to free them of severe distortion. The advantage of such single step image capture is reduced by very uneven resolution of panoramic images obtained in this way.

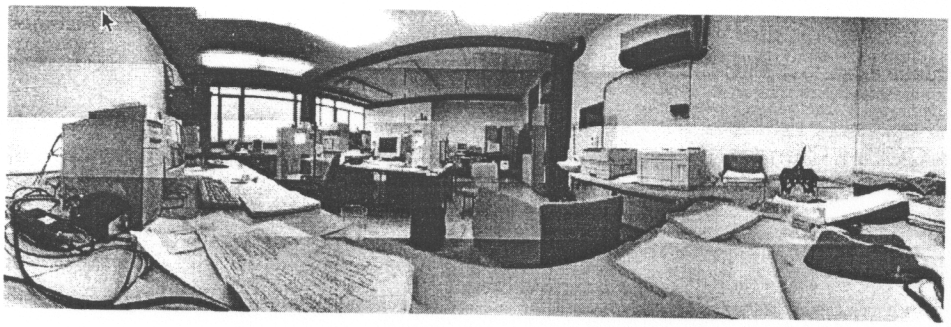

Figure 3: GlobalView perception

GlobalView is a combination of a static panoramic view and live images received from IVS. The panoramic view is generated by scanning the 360^o surroundings of the camera (from a few seconds to about 20 seconds resulting in fine or more coarse vertical image joints), transforming the consecutive images from sphere to cylinder coordinates and arranging them into a single slit (Fig. 3). Live images arriving from IVS are also transformed to cylinder coordinates to fit into the panoramic view and superimposed on the corresponding position in the panoramic view.

With this extension of IVS the user knows what he is looking at, relative to its surrounding. When we know what is around the observation point we can instantly turn in the desired direction and update the information in any particular area of the panoramic view with fresh live video. In this way the explicit step movement commands can be avoided which enables a more intuitive control over remote camera.

4 Results

The Internet Video Server has been used several times covering different events and using almost all possible communication lines between the camera level and the distribution level [6, 7, 8]. So far, the live video was transmitted using analog telephone lines, GSM mobile telephone and direct Internet connection. In the future we would like to experiment also with ISDN and microwave connections.

5 Conclusion

IVS is a system which enables live video transmission over the Internet. With GlobalView extension the observer gains a better understanding of the observed location and a more intuitive control of the camera. Video-conferencing and remote surveillance are examples of applications that would certainly benefit from such an interface.

IVS can be found on URL: **http://razor.fri.uni-lj.si:8080/IVS/IVS_Main.html**

We are also in the process of upgrading the system with a simple motion detection method which would enable the camera to automatically track a moving object.

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[8] Netropolis – Cyborg's eye, ECML'97 project,
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